

United States Naval Postgraduate School



A SURVEY OF SELECTED
OFFICER RETENTION AND GRADE-STRUCTURE
STUDIES

by

David M. Criste

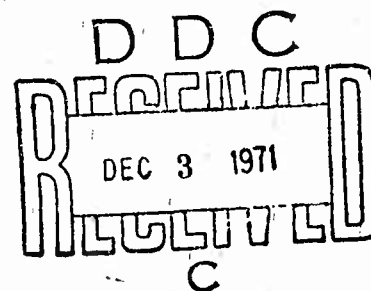
and

Kneale T. Marshall

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Rear Admiral A. S. Goodfellow, USN
Superintendent

M. U. Clauser
Provost

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This paper presents a critique of several selected studies in the areas of officer retention and grade structure. These studies are investigated to determine what methods of approach and analytic techniques were employed in accomplishing the objectives of the study group. An assessment is made of the degree of success or failure realized by each study. In discussing officer grade structure studies, this paper also presents the factors which are necessary to create an "optimal" grade structure, and reviews the current grade structures and legal constraints which act upon these structures.

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Kneale T. Marshall

Kneale T. Marshall
Department of Operations Research
and Administrative Sciences

J. R. Borsting

J. R. Borsting, Chairman
Department of Operations Research
and Administrative Sciences

C. E. Menneken

C. E. Menneken
Dean of Research Administration

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I. INTRODUCTION

This paper presents a critical review of selected studies in the areas of officer retention and officer grade structure.

The first area of investigation, the retention problem, has been the subject of numerous studies on many levels, and has received increased attention with increasing pressures for conversion of the armed forces to an all-volunteer organization.

The second area of investigation in this paper is the officer grade structure. The present grade structures have been established under ceiling constraints set by the Congress and further amended by the service secretaries. However, during periods of severe fluctuations in the total size of the armed forces, the individual services have considerable latitude in adjusting their grade structures. A structure which is optimal for a total force of a certain size may be far from optimal when the total force is greatly expanded or reduced. Further, no clear cut criterion for determining the "optimal" grade structure has been established nor is it clear that any such criterion exists.

In this paper, the method of review for these selected studies involves three basic steps:

- 1) Determine the objectives of the study.
- 2) Describe the techniques/methods of approach used in the study.
- 3) Determine the degree of success or failure of the study.

Each study is analyzed in light of its specific objectives, since a knowledge of these objectives contributes to an understanding of why a particular method of approach was used in one study and not in another.

It is possible in some cases to judge the degree of success or failure realized by the study. The criterion for judging this success is in general the degree to which the results and/or recommendations of the study have been incorporated into present procedures for improving officer retention or modifying the existing grade structure. Another important criterion is whether or not the study gives insight into the structure of the officer personnel system, whether or not it pin-points the important variables, and whether or not it leads to the design of new or better systems. This last point is important if a given study is to do more than make marginal changes to the current system.

The following major studies have been chosen as subjects for this review:

- 1) Institute of Naval Studies, Study No. 13, Manpower Considerations Applicable to the Navy in the 1970-1980 Time Period, Annex B, Officer Survey, 1965.
- 2) Institute of Naval Studies Research Contribution #17, Predicting Effectiveness of Incentive Programs for Various Groups of Naval Officers, by Charles M. Harsh, 31 March 1966.
- 3) Office of the Secretary of the Navy, Report of the Secretary of the Navy's Task Force on Navy/Marine Corps Personnel Retention, 1966.
- 4) The Franklin Institute Research Laboratory, Career Motivation of Army Personnel - Junior Officer Duties, 30 September 1968.
- 5) Department of the Army, Office of the Deputy Chief of Staff for Personnel, Officer Grade Structure Study, 1969.

II. OFFICER RETENTION STUDIES

Studies in this field concentrate on factors (mostly behavioral) which affect the retention of officers, and are intended to support manpower management programs by predicting retention rates. In some cases, attempts have been made to estimate the cost and effectiveness of proposed programs for improving retention.

As an example of the type of results obtained through officer retention studies, consider one finding of the Institute on Naval Studies Study 13, Navy Manpower Considerations, 1970-1980. Results of the officer survey section of this study indicate that the career intentions of a young (age 25-27), married naval officer are generally more favorable than those of an unmarried officer of the same age. However, these intentions are influenced by the officers' wives' dissatisfaction. The survey also determined that wives who want their husbands to leave the Navy are much less concerned about income than about poor housing facilities, medical care, frequent moves, and prolonged separations. These results suggest a need for the Navy to concentrate its efforts toward improving housing and medical attention, reducing the number of moves a family must make, and easing the burden imposed by separation. Recent actions indicate that increased attention is being directed toward these areas by Navy authorities.

A. INSTITUTE OF NAVAL STUDIES, STUDY 13, NAVY MANPOWER CONSIDERATIONS, 1970-1980. [Reference 1]

This study was conducted in 1965-1966 as a follow-on to the Institute of Naval Studies "Manning the Future Navy," Study 11, 1964. The modeling

techniques and methods of quantifying decision data demonstrate the value of the analytic approach to studies in the field of personnel-related research.

The primary objectives of the study were: [Ref. 1]

"(1) To study factors of personal characteristics, background and Navy experience which might be related to the retainability of officers.

(2) To estimate the effectiveness of a variety of incentive changes as a means of encouraging longer active duty careers."

The study was exploratory, and was intended to give insight into the relevant factors which could be used by the Chief of Naval Operations in policies relating to selection, training, utilization, and retention of officers.

The study relied heavily on the responses to questionnaires. These responses were used to assess relationships between an officer's service intentions and a variety of factors, such as family background, education, occupational and income aspirations, family pressures, reasons for entering the Navy, types of duty, satisfying and frustrating experiences, career objectives, comparisons of Navy and civilian life, and statements as to how present service plans would be altered by the introduction of various incentive changes. The survey group consisted of a stratified random sample of Navy officers (from Ensign to Captain inclusive), with membership composed of 10% of all Unrestricted Line Officers and 20% of all Staff Corps and Restricted Duty Officers. Those completing questionnaires remained anonymous, and a total of 9350 questionnaires were returned from an initial mailing of 9980.

It was assumed that this constituted a representative sample of the active duty officer population.

The best retention criterion for officers was assumed to be the officer's stated career intention, and it is upon this critical assumption that the applicability of the results of this survey rests. In any case, it was felt that an officer's response to various proposed incentives could give a valid estimate of the relative effectiveness of different incentive programs. Using this retention criterion, the analysis was mainly used to discover what factors differentiate among groups whose career intentions are undecided, those who intend to leave the Navy as soon as possible, those who intend to retire after 20 years of service, and those who intend to remain in the service as long as possible.

The results of the survey were analyzed using multiple regression techniques. A total of 284 primary variables and 261 derived variables were established and investigated, then trivariate analyses were computed for about 150 of the many possible combinations of three variables at a time. Summary relationships between pairs of variables were generally felt to be deceptive because of the confounding effects of other factors, such as age, family, and career motives, so these relationships were not used.

In this study a total of 13 specific retention incentives were introduced and investigated. Each incentive was introduced by asking the officer in his response to indicate how this particular incentive would influence his present career intentions. His answer was indicated by checking one of the following responses:

- a. Would greatly strengthen my desire to pursue a long career in the Navy.
- b. Quite favorably, I would continue active duty several years longer than now intended.
- c. Favorably; without changing my present intentions.
- d. No effect on my service intentions or Navy attitudes.
- e. Would make a Navy career somewhat less desirable for me.

The study group estimated that the value of the incentive was indicated by the percentage of officers choosing either of the first two responses.

The attractiveness of the 13 incentives was then measured as they affected different career intentions ("Leave Soon," "Undecided," and "Retire at 20 years"), grouping based on rank (which was highly correlated with age), and grouping by designator (Unrestricted Line, Aviators, Supply and Civil Engineer Corps, Medical and Dental Corps, etc.). Attractiveness was also measured as it appealed to other factors of the officer population such as source of commission, family status, spouse's attitudes, income standards, and Navy experiences.

Results of questions concerning these incentives were displayed in the form of graphs and tables, and significance tests between groups were made at the 0.01 level or better in order to check whether the observed differences between groups are likely to be real, or can be attributed to chance. Trivariate analysis was used in the construction of these displays. For example, analysis of an officer's rank and career intentions was conducted versus attraction of incentives. Primary attention was focused on officers whose career intentions were "Undecided" and who were

in age group 25-27, as this group of officers obviously held the most promise as a source of retention candidates.

Based on the responses to the officer survey questionnaire, it was apparent that the "Undecided" officer and the officer with the intention to "Retire at 20 years" perceive many of the same objectives and rewards of Navy life, while the "Leave Soon" group generally have objectives which are not suited to Navy life. In response to the 13 incentives, none of the 13 held great attraction to the "Leave Soon" group, while the "Undecided" and "Retire at 20 years" groups were in substantial agreement in their responses to almost all of the incentives. The implication was that while an incentive which appeals to the "Undecided" officer will offer little attraction to the "Leave Soon" officer, neither will that incentive cause any career motivated officer to decide to leave the Navy.

In evaluating the responses to this portion of the INS Study, it should be borne in mind that the percentage of favorable replies to an incentive should not be judged as the indicator of the absolute worth of that incentive. In light of previous and subsequent studies of the same nature, it would appear that at best the percentages give a relative standing of the impact of each of the suggested incentives.

A survey method of this size is obviously an expensive undertaking (the cost of this survey was approximately \$200,000), but an analysis such as this requires large sample sizes to ensure that each cell in the analysis contains a large enough sample to minimize the effect of sampling errors. In the same vein, it was felt that cell frequencies would be too small to trust when investigating multivariate relationships of four or

more variables simultaneously, and thus trivariate relationships were studied almost exclusively.

One method of assessing the success of this study is to note that many of the results were used by the Secretary of the Navy's Task Force on Navy/Marine Corps Personnel Retention in 1966. The outcome of the Task Force recommendations can readily be seen from the Secretary of the Navy's specific action taken on each recommendation. Thus, some results of the INS Study 13 were transformed from survey responses into implemented Navy-wide policies and procedures in a rather short period of time. Referring to the previous example on the attractiveness of certain of the 13 incentives, the obvious preference for items involving an increase in pay/compensation led to the Task Force's submission of 14 specific recommendations on improvement in the area of pay and compensation; the Secretary of the Navy approved 12 of these 14 recommendations.

However, it must be kept in mind that the study was exploratory and concluded by recommending additional study programs to:

1. Determine personal characteristics and experiences related to effectiveness,
2. Determine combinations of incentives which would best retain effective officers in certain categories, and
3. Develop officer feedback measures and other assignment criteria to increase officer satisfaction as well as Navy effectiveness.

It should be noted also that the information presented by this study might be used to give a fairly accurate estimate of the retainability of officers, but it does not show the best means of retaining those officers

who may be the most effective or most needed by the Navy. Therefore, the insights gained from this study should be carefully reviewed against better criteria of officer desirability when attempting to transform these insights into policy programs designed to retain the most effective officers, or officers possessing a particularly desirable skill.

A final point is that the results of this study rely for accuracy on the survey response. The pitfalls of this approach are well known, and an implicit assumption the modeller must make is that if the various incentive policies suggested in the questionnaire were put into practice, then the officer responding would in fact behave in a way consistent with his hypothetical responses.

B. INSTITUTE OF NAVAL STUDIES RESEARCH CONTRIBUTION #17, PREDICTING EFFECTIVENESS OF INCENTIVE PROGRAMS FOR VARIOUS GROUPS OF NAVAL OFFICERS, by CHARLES M. HARSH. [Reference 2]

This study is an extension of the analysis of data gathered in the officer survey portion of INS Study 13, Navy Manpower Considerations, 1970-1980. The study develops a method for estimating the effectiveness of various officer incentive programs, and attempts to assign a relative cost to several alternative combinations of incentives.

The objectives of the research contribution were to: [Ref. 2]

"(1) Develop a method for estimating effects of incentive programs, making allowance for continuance probabilities for officers with different service intentions.

(2) Compare several combinations of incentives with regard to their probable effectiveness in retaining officers of certain age and designator groups.

(3) Determine the relationships between incentive appeal and Navy promotional criteria for officer effectiveness.

(4) Examine the relative appeal of incentives for officers with various backgrounds, career objectives, and Navy experience."

The analysis here relied on the data base obtained in response to the officer survey portion of INS Study 13. Additional computer runs subsequent to the release of Study 13 provided the data for investigating the appeal of incentive factors to career objectives. As in Study 13, the primary method of evaluating the effectiveness of combinations of incentives was trivariate analysis.

This study recognized that some of the results of Study 13 may have been distorted by the use of percentages of members in each group responding to incentives, and attempted to present a clearer picture by using actual numbers of officers who indicated they would extend service in response to an incentive. Also, in attempting to establish actual numbers of officers who would extend service, and place some relative cost on the various incentives, the technique of "Continuance Prediction" was developed.

Continuance Prediction is simply an assumption of stationarity in the behavior of different age-groups of the officer population; i.e., different groups are assumed to behave in a similar manner through time. The simplified equation for continuance prediction is:

$$L_{a-1} P_1 + U_a P_u + M_a P_m + S_a = N_{a+1}$$

where L_a represents the number of officers in age group a whose stated intention is to "Leave Soon," U_a is the number of officers in age group a whose intentions are "Undecided," M_a is the number of officers intending to serve for 6 to 16 years, S_a is the number who intend to serve for 20 years or longer, and N_{a+1} is the number of officers continuing into the next age group $a+1$. It is desired to determine the continuance proportions P_i ; $i = l, u, m, s$, assumed constant from age group to age group (i.e. independent of a) to determine how many officers will continue into the next higher age group. The subscripts l, u, m, s refer to leave soon, undecided, serve 6 - 16 years, serve 20 years or more respectively. It is assumed that $P_s = 1$, i.e., all officers intending to serve for 20 years or more would continue to the next age group.

To solve for the most likely values of P_l, P_u , and P_m , three equations were written for the three age groups (20-27, 28-33, and 34-40), using values of L, U, M , and S from the officer survey sample group (N had been shown to be fairly constant for the previous eight years). The three equations were solved simultaneously yielding the continuance proportions of $P_l = .044, P_u = .694$, and $P_m = .756$. These proportions agree with ones intuition of what the officers in these categories might be expected to do.

On page 6 of Ref 2 the author claims "phenomenal" agreement when estimated N agree exactly with the actual N when calculated from the equations. Since he is determining an identity by substituting back into the equations he has just solved, any disagreement could be caused only by arithmetic errors. No independent test of the stationarity

assumption is given, and its validity is open to serious question. It does not seem realistic to think that, for example P_u would be independent of the age group, that the same proportion (.694 in the report) of undecided in age group (20-27) and (34-40) would continue to the next age group. In fact, it is not clear how the study accounts for the last age group. The P 's determined are "average" continuance proportions for all age groups.

Using the original survey information on attractiveness of incentives to officer groups with different intentions, and having estimated the probable continuance of officers with different service intentions, the study then developed a method for estimating the probable gain in service extensions which would result from several of the different incentive combinations. This expected number of extensions within each designator and age group can be estimated by the equation:

$$(1 - P_l)E_{la} + (1 - P_u)E_{ua} + (1 - P_m)E_{ma} = G_{a+1}$$

where E_{la} is the number of officers whose intentions are "Leave Soon" who say they would extend service in response to this particular combination of incentives. E_{ua} and E_{ma} have similar interpretations for the "Undecided" and "Intend to serve 6-16 years" categories in age group a . G_{a+1} is the probable gain in age group $a+1$ and the P_l , P_u , and P_m are interpreted as before. Therefore, the quantity $(1 - P_l)E_{la}$ represents an additional number of officers in age group a with intentions "Leave Soon" who now will extend service in response to the particular incentive.

This estimation technique was used for many combinations of incentives, age groups and designators. The results, in tabular form,

show the estimated number of officers in each designator and age group who would be expected to extend service in response to a particular combination of incentives (e.g. Specialization and Better Housing, or Civil Service Equivalent). With these estimated numbers, it is now possible to determine the cost of a particular choice of incentives. The study found that in some cases, two sets of incentives which would expect to attract about the same number of officers may result in costs which are two or three times greater for one set of incentives as compared to the other. This type of analysis represents a significant step in the introduction of cost-effectiveness analysis into the field of retention, and also provides a means for introducing different incentive programs while keeping in mind both Navy requirements and budget constraints. Hopefully, refinements of this technique will permit the Navy to select and introduce (at a reasonable cost) that combination of incentives which will attract officers from a desired category without also retaining too many officers in categories which are less desirable.

In summary, this study has attempted to develop techniques for estimating continuance probabilities, and to determine the effects of several incentive programs on different age and designator groups. Cost-effectiveness analysis was introduced as an aid in comparing alternate incentive programs. No single incentive will accomplish each particular aim of the Navy, but the study does suggest a method for developing trade-offs between objectives of the Navy and the costs involved in introducing incentives. Although some false conclusions are drawn from testing the model assumptions (especially stationarity), the unsophisticated aspects of the model are one of its advantages.

C. OFFICE OF THE SECRETARY OF THE NAVY, REPORT OF THE SECRETARY OF THE NAVY'S TASK FORCE ON NAVY/MARINE CORPS PERSONNEL RETENTION.
[Reference 3]

This Task Force was established by the Secretary of the Navy in early 1965 with the purpose of conducting a comprehensive review and analysis of the factors affecting retention of Navy/Marine Corps officers and enlisted personnel. The results of the Task Force were presented to the Secretary of the Navy in the form of a series of recommendations designed to improve retention. These recommendations were acted on by the Secretary in early 1966 when each was individually accepted, rejected, or deferred for further study.

The mission of the Task Force was: [Ref. 3]

"(1) To identify and examine the major factors bearing on retention of high quality officer and enlisted personnel.

(2) To develop a plan for attacking these retention problems which was to include:

- a. specific recommendations
- b. a program to implement the recommendations;

and

c. identification of the specific Government officials or agencies who are presently empowered to implement such actions."

The scope of the study was extremely broad, to the extent that anything which would improve the naval service could be considered as being a factor affecting retention and as such was a bona fide area of interest of the Task Force study.

Major information sources for the study consisted of:

1. Fact finding by the Task Force members, including major contributions from the Bureau of Naval Personnel and Headquarters, Marine Corps.
2. Letters which were solicited from Navy/Marine Corps personnel, their wives, and other interested persons.
3. Naval Personnel Survey 64-1.
4. Various Institute of Naval Studies efforts (including Study 13, Navy Manpower Considerations, 1970-1980, which has been reviewed in this paper).
5. A National Opinion Survey conducted by Louis B. Harris and Associates.
6. Symposia conducted by the Task Force members meeting with Navy/Marine Corps personnel and their wives in Norfolk, San Diego, and Quantico.
7. Other bureaus and offices within the Navy Department.
8. All major fleet and type commanders.

In addition, many special studies on more specific aspects of the retention problem were either conducted especially for the Task Force, or made available to the members of the Task Force.

Two mathematical models were used to assist in the Task Force effort to relate the available data and statistics to measures of cost and effectiveness, and the trade-off between these measures. The first of the models was the MARCIA (Mathematical Analysis of Requirements for Career Information Appraisal) model, developed by the Bureau of Naval Personnel, while the second model was one developed by the Task Force using the concept of productivity as a measure of effectiveness, measuring costs in terms of productivity under various programs with

different retention levels.

The first model, MARCIA, was designed to determine steady-state impacts of changing promotion rates, career ratios, continuance rates, and billet structure. The MARCIA model is a linear programming model which varies the input parameters (retention rates, length of obligated service, and pay grade structure), to produce an output consisting of a rating structure by pay grade and length of service to sustain required billets. Along with this rating structure profile, the model indicates associated costs and the values of effectiveness derived (effectiveness measures were developed by the Task Force based primarily on pay grade, rating, time in pay grade, and promotion factors). The model produced an "optimal solution" which maximizes the effectiveness to cost ratio. The MARCIA model was developed to deal only with investigations of enlisted personnel retention, and therefore will be discussed no further in this paper. Appendix K of Ref. 3 describes the model in detail.

The second model, the Cost-per-Productive-Man-Year Model, was also developed primarily for use in studying enlisted retention. Considerable effort was expended attempting to define and adequately quantify "productivity." This was done by building a data source from the Navy's 3M Aircraft Maintenance System, determining what productive work was accomplished by men of different grade, different ratings, and different amounts of experience in grade and rating. This information was transformed into "utilization factors" for development of productivity details which then became a part of the Cost per Productive Man Year to determine the cost of different Navy careers as a function of continuance of the

enlisted member. The model investigated inter-relationships among cost, production, and force size, and conducted comparative cost analyses for alternative manpower resource levels and alternative retention proposals, such as sea pay for officers. The model and its computer program are further described in Appendix J of Ref. 3.

The study attempted to back up each recommendation with mathematical analysis, but this was not possible in all cases because of the inability to quantify all the factors bearing on retention. In these cases, Task Force members attempted to support their findings with logic and judgement. The study effort was of such overall magnitude that retention considerations were broken down into such subcategories as personnel management, improvement, officer promotion, opportunities, officer distribution, education and training, living conditions afloat and ashore, the image of the Navy/Marine Corps, medical care, and pay and fringe benefits. Each subcategory was analyzed and resulted in recommendations pertinent to that field of interest. It is not possible for this paper to present all of the techniques employed by the Task Force; however, some of the highlights are presented.

Officer retention was viewed from two aspects; the quantitative problem, and the qualitative problem. In the quantitative area, the Task Force studied stated requirements versus numbers of officers available and revealed serious imbalances in several communities at different ranks. The study delved deeper and discovered that even in cases where there does not appear to be a quantitative problem, some discrepancies exist. The Medical Corps presents such a problem, where specialization

prevents officers of the same rank from being interchangeable. The Task Force accepted the existing billet structure as being a valid representation of the actual needs of the Navy, but pointed out that this structure should be investigated further to determine if it is indeed valid. In investigating the quantitative problems the Task Force did no detailed analysis of specific aspects of the problem; it simply presented the statistics revealing the number of billets and the number of officers presently available in each grade and branch of the service, and then drew attention to those areas where chronic imbalances existed.

Problems of a qualitative nature were also found to exist. Selectivity for promotion has been considerably reduced for middle grade officers, and has yielded some undesirable effects. In addition, technological advancements indicate that a greater need currently exists to maintain a high quality officer community by improving management in the fields of career planning, education, and use of officer abilities.

In the area of officer promotion opportunities, the Task Force recommended proposals to streamline the promotion procedure, permitting accelerated promotions for more promising officers, and providing for greater authority to selectively not continue some senior officers. The most far reaching of the recommendations was the call for adoption of a Distribution Zone Promotion Plan. This plan was developed through extensive data collection and analysis of previous promotion patterns, and was then presented in the form of recommended selection and attrition rates based on years of completed commissioned service for different officer communities (i.e., Unrestricted Line, Supply Corps, Civil Engineer

Corps, etc.). The major objective of this and other recommendations on promotion opportunities was to increase retention and pride in the Navy officer corps by demonstrating recognition of superior performance through accelerated promotion and assignment to key billets. Although the motivation for Distribution Zone Promotion and other promotion recommendations was to improve retention through rewarding superior performance, no analysis was conducted to determine exactly what effect these actions would have in terms of the quantity and quality of officers retained.

Personnel surveys conducted in 1964 and 1965 provided some of the data and pointed the direction to some of the Task Force recommendations in the areas of officer distribution, training, education, living conditions, image, medical care, and pay and fringe benefits. Wherever possible, the Task Force attempted to assign costs to the recommendations presented. In some areas (promotion, officer distribution and management, and image), the costs of changes were minimal. However, sizable funding would be required to implement recommended changes in officer education and training, living conditions, medical care, and pay. Preparation of cost data constituted some of the most concrete analysis undertakings of the study.

Another analytical contribution to the study was the set of statistical studies developed for Navy enlisted personnel, Navy officers, and Marine Corps officer and enlisted personnel. These studies provided an overview of the statistical picture of these groups. This includes data on grade strength, promotion and procurement experiences, retention experiences, and comparisons of present structures with the "ideal" structures as envisioned by law and billets as presently established. Conclusions have

been drawn from certain of these statistical studies in the sub-categories of the overall Task Force study.

The Task Force established a Technical Support Group to develop analytical techniques for testing and refining of Task Force recommendations. Most of the techniques developed, such as continuance rate models, were applied to enlisted retention considerations. However, considerable effort was also expended in the development of the cost and effectiveness models mentioned above. Additionally, many retention factors were analyzed as problems of supply and demand.

The analytical efforts of this study did not end with the publishing of the final report and dissolution of the Task Force. In fact, they were still expanding, and the study pointed out where further work was to be done. Problems encountered in the study indicated that further studies were needed in such areas as:

- (1) Determination of manpower requirements and inventories, along with points of imbalance between the two.
- (2) Methods of measurement and control of the supply of personnel entering or continuing in the system.
- (3) Development and use of manpower management information systems.
- (4) Development of information sources.

In accomplishing its mission, the Task Force's recommendations by and large, received considerable approval from the Secretary of the Navy. Most of the recommendations which were not approved were either disapproved because of budget limitations or were deferred pending further study. To the extent that implementation of recommendations represents success of

this Task Force, it must be considered that the study was highly successful. However, to the extent that the retention problem has been solved or eased in the intervening five years, it must be considered that the study was not nearly so successful, especially in solving the quantitative aspects of the retention problem.

D. THE FRANKLIN INSTITUTE RESEARCH LABORATORIES, CAREER MOTIVATION OF ARMY PERSONNEL - JUNIOR OFFICER DUTIES. [Reference 4]

This study was prepared for the Deputy Chief of Staff for Personnel, Department of the Army and was published as a two volume report on 30 September 1968. The study attempted to identify factors which have an influence on Army officer career decisions. The study objectives were to: [Ref. 4]

"(1) Determine the relationship between extrinsic (environmental) factors such as pay, duty assignments, and fringe benefits, and intrinsic factors such as pride, challenge, satisfaction, and independence.

(2) Determine the relationship between extrinsic and intrinsic factors and junior officer retention.

(3) Specify what changes to the extrinsic factors are most likely to influence the intrinsic factors, and, thereby, improve junior officer retention."

The subjects selected for this study were Army company grade officers with more than six months but less than five years of active commissioned service. Emphasis was placed on duty assignments, the content of these duties, and career management.

A total of 4532 officers, stationed both overseas and in the United

States, took part in this study. This officer sample group represented a stratified two stage selection with primary stratification across branches (i.e., Infantry, Artillery, Engineer, Chemical, etc.) and supplementary stratification across ranks (Captain, First Lieutenant, Second Lieutenant). Data was collected through group-administered questionnaires in the United States, and a mailed survey for the overseas subjects. All subjects remained anonymous.

Between 312 and 389 separate responses were obtained from each officer, depending on his service status and career convictions. Space was provided for written comments at the end of the questionnaire and more than one-third of the subjects submitted some comments. Additionally, informal discussions were held by interviewers with participants in the United States. These discussions, which were not mandatory for the participants, were used to further investigate the attitudes and reactions of the officers. A pilot interview program was used to remove some ambiguity and streamline questionnaire actually administered to the participants of the main study. In addition, a validation sample of 113 officers who had been separated from the Army in the past two years was questioned. The purpose of this validation was to gain a different perspective of retention and perhaps point out possible contradictions or biases in the main study findings.

The questionnaire and study effort were organized to permit analysis on two separate but concurrent levels; quantitative and qualitative. The objective of this approach was to solicit recommendations or comments from the participants on matters about which they felt strongly. The

comments were reviewed and analyzed qualitatively without the use of any statistical techniques; the study designers simply wanted to discover areas which may not have been covered by the questionnaire, to highlight areas where further investigation might be justified, and to provide some means of corroborating the findings of the quantitative analysis.

In the first question each participant classified himself as "staying," "leaving," or "undecided," with various degrees of inclination toward one of these categories. The officer's declared service intention, based on the reply to this question, was used as the dependent variable in investigating the intrinsic, extrinsic, and duty factors which affected him.

The principal analytic techniques used were canonical analysis, principal component analysis, and the more conventional stepwise regression analysis. The canonical correlation analysis [Refs. 9 and 12] was conducted on correlation matrices of the extrinsic, intrinsic, and duty variables using data from the three groups of officers. Hypothesis testing indicated that interclass dependence does exist between these variables, but the correlations between the variables were so low and sensitive to extreme values that canonical variates could not be used in a predictive sense. Because of this, it was felt that the Hotelling principal components technique [Ref. 8] would describe the dependencies of the three types of variables (intrinsic, extrinsic, and duty) in a more useful manner.

The Hotelling principal components analysis was carried out on the correlation matrices of the extrinsic and intrinsic items and computed from the three groups ("staying," "leaving," and "undecided"). A program

from the BIOMED Program Package [Ref. 11] was used in this analysis. First principal components were used to determine the six extrinsic factors of lowest and highest weights for each officer group. (As an example, the "leaving" group seemed to place a higher value on material success, such as promotion, housing, and pay, than did the "staying" group).

The second principal components are in essence comparisons of the extrinsic and intrinsic scores of the officers, while third principal components consist of comparisons of certain favorable extrinsic Army benefits and some of the less favorable aspects of Army life.

The study group also used stepwise regression models [Ref. 13] to investigate the effects of intrinsic, extrinsic, and overview^{*} factors on retention. The output of these three models was used as input to another regression model designed to analyze more closely how the Army might influence the "undecided" officer.

Another undertaking of the study was the effort to establish relationships between certain socio-economic and service status factors. The effect of each of these factors on retention was measured using the non-parametric Kolmogorov-Smirnov and Chi-square tests [Ref. 14]. Some of these socio-economic factors included source of commission, rank, branch, racial group, father's occupation, and education level attained.

*(Those not listed specifically in intrinsic or extrinsic factors or the list of duties).

The result of all the preceding analysis was the development of a Retention Model, by integration of the previous modeling steps. The purpose of this model was to investigate changes in retention resulting from changes in those factors which are controllable. This model led to a series of specific analyses of the significant variables discovered. The study revealed those intrinsic factors considered most important (i.e., sense of achievement, sense of challenge, responsibility, independence) and also determined that these intrinsic needs are primarily satisfied by job content of duty assignments, and not by the extrinsic factors such as pay, housing, and retirement.

Having had some success in identifying those factors which have a significant effect on retention, the question of what effects various proposed Army actions would have on retention was studied next. A Resource Allocation Model was developed to predict retention and cost effects of new programs or policies. This model attempted to determine how many officers might be retained, and the distribution of these officers by rank, branch, marital status, and several other profile items.

The model analyzed the results of the study questionnaire section on "The effects of proposed changes in extrinsic factors on career decisions." The effect of each of the 48 proposed changes was measured and tabulated in the form of a total of officers retained by this change. However, it was realized that many of the responses to the proposed changes reflected

more wishful thinking than carefully weighed consideration on the part of the respondents and therefore the choices of proposed changes were weighed not so much on their absolute effects as they were for their relative magnitude.

Based on the questionnaire answers, the Resource Allocation Model proceeded iteratively to accept individuals into the "Staying" group of officers. The analysis used a weighted probability function to help determine the number of officers who would be expected to join the "Staying" group as the result of some extrinsic factor, considering different probabilities of this actually happening depending on whether the officer had previously been considered "Leaving" or "Undecided."

This weighted probability function was constructed to measure the number of officers who would actually remain in the service, given the number of officers indicating each of the different career intentions. Recall that each officer was asked to indicate his service intention and his answer carried a numerical weight ranging from 1 ("I definitely intend to leave active duty as soon as possible") up to 7 ("I definitely intend to make a career in the Army"). Next, probability values were assigned to the percentage of officers in each response category who would actually remain in the Army. For example, the probability of staying in the Army, given a "1" or "2" response, was assumed to be negligible (1 percent), but this probability was expected to increase with increasing responses "3" through "6", and finally was assumed to be not less than 85 percent and not more than 95 percent, given a "7" response. Based on these assumptions, maximum and minimum numbers of officers expected to stay in the Army were computed for the extrinsic factors. In addition, techniques

were introduced to reduce the "wish-list" effect on each of the officer's responses.

One drawback of this analysis was that of ten extrinsic factors considered most important by the respondents, five of them, including the top three, were related to duties, which was the most difficult area to deal with from the resource allocation point of view. As an example, the factor which had the greatest response was "Utilized officers' assignment-preference statement to a greater extent in actual assignment to duties." Because of the rather general nature of this and other duties-related responses, most of the model's analyses were run while excluding duties-related items. Thereafter, the factors investigated most thoroughly primarily concerned education and allowances.

The factors which seemed most promising were then analyzed in packages of three at a time and tabulated by profile groups to assess their effects on numbers of officers retained as a result of the incentive package. Further methods were introduced to reduce "wish. list" effect which was apparently inflating some of the response figures.

The result of analysis using this model was a fairly consistent indication of areas of major interest to retention improvement. Implementation of programs to alleviate problems in any and all of these areas was predicted to increase junior officer retention from the present 18% to rates in the range of 24-40%, depending on which and how many of the factors were implemented as programs or policy changes.

Returning to the validation study conducted using responses of officers recently separated from the Army, it was determined that the validation study was in close agreement with results obtained through

the Retention Model. The profile of those separated officers most closely resembled the profile of those officers who were grouped as "leaving" by their stated intentions. No conclusion or recommendation of the main study was amended as a result of these validation study findings.

The culmination of this analytic study was the Retention Model's representation of the junior officer as a decision maker. The three career groups ("staying," "leaving," and "undecided") were characterized by certain factors which were most significant in their decision making. These findings, together with the knowledge of effects of proposed changes provided by the Resource Allocation Model, were used to develop the recommendations of this study. These recommendations were categorized as major or minor. Each major recommendation would be expected to influence the undecided officer toward an Army career, while each minor recommendation would not on its own influence an officer toward a career, but taken cumulatively would be expected to exert a staying influence on the undecided officer.

A total of 44 study recommendations were subsequently approved by the Secretary of the Army and have been implemented as Army policies [Ref. 15]. The majority of these recommendations involved actions involving assignment of duties, career counseling, education programs, information programs for Army wives, housing programs, and improvements in ROTC training. It should be noted that the study presented no major recommendations calling for increases in basic pay or retirement benefits. Therefore, none of the accepted recommendations of the study required the expenditure of large sums of money, nor did any of the programs require authorization from officials outside of the Department of the Army.

III. OFFICER GRADE STRUCTURE STUDIES

The purpose of this section is to investigate officer grade structures and methods of improving upon current structures. We first discuss some considerations as to what constitutes an optimal grade structure. Next, the current structures are discussed; how they were established, what legal restrictions are imposed on the structures of each of the armed services, and how these structures change with changes in national or Department of Defense policy. This section concludes with a review of a recent study, the Officer Grade Structure Study, prepared by the Personnel Studies Division, Directorate of Personnel Studies and Research, Office of the Deputy Chief of Staff for Personnel, Department of the Army. The study was published in March, 1969.

A. CONSIDERATIONS CONCERNING AN OPTIMAL GRADE STRUCTURE

No single criterion exists for indicating when a structure is "optimal." It might be expected that the relationship between the size of the total officer force and the total armed force of a service is not linear. Additionally, officer distribution by rank varies with the total officer force size. Finally, each service requires a different grade structure to accomplish its missions. Thus the form of an acceptable grade structure may be different for the Navy, Army, Air Force, and Marine Corps, and the structure for each service will change as the total size and mission of the service change.

In the absence of a criterion for determining optimality, the services have developed guidelines for acceptability and desirability to judge a proposed grade structure. When using such guidelines, proposed new

structures are judged on their acceptability or desirability relative to the present structure. The problem of how to move from the present structure to a proposed new structure plays a major role in evaluating the new structure. For example, suppose the present Navy grade structure contains 6500 Aviation Lieutenant Commanders, and a new structure is proposed which requires only 5000 Aviation Lieutenant Commanders in the near future. This new structure may have many advantages over the former, but it has the undesirable feature of having an excess of 1500 officers in the short run. These officers are in the middle of their careers, have been trained at a considerable expense, and now have suddenly become unneeded. This presents the Navy with a problem of sustaining an effective and efficient fighting force while still providing adequate career security to its officers. Transient problems of this sort must be recognized and addressed when proposing changes in the officer grade structure.

The following are guidelines of acceptability, or constraints, which any proposed structure should satisfy. It should:

(1) Meet mission requirements in terms of officer strength both in total and in each grade at each time period.

(2) Be an acceptable structure in the view of planners and policy makers.

(3) Be acceptable to prospective members of the Officer Corps, to attain the required retention by permitting service careers to be attractive.

(4) Be sustainable through the planned time frame.

(5) Be attainable from the current grade structure, allowing for some acceptable time for transition and some level of disruption to those presently in the structure.

(6) Conform to current laws and Department of Defense guidelines in reaching prescribed limits within acceptable transition times.

Certain desirable features are also expected from a proposed officer structure. These features can be looked upon as objectives of the proposed structure, and include the following:

(1) The structure must provide qualified officers in sufficient numbers to meet national objectives in time of war.

(2) It must be flexible enough to adjust to changing force levels and short term policy changes.

(3) It must provide continuous intake of junior officers, and provide for realistic retention rates.

(4) It must retain skilled career personnel and provide career opportunities which realize the skills and experience developed by these officers.

(5) It must allow an orderly promotion flow, following a predictable pattern, for all age and grade groups.

(6) It must offer compensation through advancement which will motivate the career officer and remain competitive at all stages of advancement.

(7) It must provide quality control in promotion and separation of officers.

(8) It must provide equality of opportunity to officers of all branches and components.

Finally, a proposed structure should replace the present one only when some significant advantage is clearly attainable.

These guidelines, in the forms of constraints and objectives, may not be the only criteria for determining an optimal grade structure. However, they do provide a means of judging any proposed structure against the existing system. It should be recognized that some of the guidelines may not always be consistent or compatible with each other, and these inconsistencies will require compromise in proposed grade structures.

B. CURRENT OFFICER GRADE STRUCTURES

Existing officer grade structures vary somewhat among each of the armed services. For each service, the structure is divided into cells containing the number of officers in each grade and then further divided in accordance with each service's organization. For example, the Navy Officer Corps is categorized by unrestricted line, restricted line, staff corps, and limited duty officers, while the Army Officer Corps is categorized into five groups: Regular Army Career Officers, Other than Regular Army (OTRA) Career Officers, Regular Army Junior Officers with less than five years active federal commissioned service, OTRA officers with less than five years active federal commissioned service, and Recalled or Voluntary Active Duty Reservists.

Grade structures are then further broken down by branch or by occupational designations (e.g. MOS). The type of breakdown varies from service to service, just as the branch and MOS designations vary from service to service. Some of these categories are arbitrarily established

and manned by the service; however, the number of officers permitted by major category and rank for each service has been established by legislative action.

Overall service officer strength and rank distribution are basically governed by the provisions of Title 10, U.S. Code (the Officer Personnel Act of 1947 [Ref. 6]). This act provides ceilings on the total officer strength, based on the enlisted strength of each service. The act also prescribes a ceiling on the number of officers authorized within certain ranks, as a function of the total officer strength. The distribution of grades for the ranks of major (lieutenant commander) and above is controlled by the Officer Grade Limitation Act of 1954 (Public Law 83-349) [Ref. 7]. The ceilings established by this law apply not only to the number of officers in each grade, but also to the numbers in each branch (for the Navy, separate ceilings are established for Line, Supply Corps, Civil Engineer Corps, Medical Corps, Dental Corps, Medical Service Corps, Nurse Corps, and Chaplain Corps). In practice, these ceilings are seldom met, and in the case of the Navy, the Secretary of the Navy has established officer strengths at the level roughly 10% below these statutory ceilings. The limits established in this manner are called "prescribed ceiling."

Legislative constraints are also applied to promotion policies. The Officer Personnel Act of 1947 provides the officer promotion machinery for each of the armed services. Among other things, this act establishes categories of officers for promotion purposes, and from these categories, zones of promotion are established. These "promotion zones" are established by the service secretaries prior to the convening of the appropriate

promotion selection board. The size of the promotion zone is a function of several factors such as (1) the number of vacancies expected to exist in the next higher grade, (2) a rough approximation of the desired promotion rate (percentage of officers in the promotion zone to actually be selected for promotion), and (3) the time in grade for an officer in his present grade.

Promotion selection boards are not tightly bound to the approximate promotion rate envisioned by the service secretaries; therefore, actual promotion rates will vary somewhat from year to year. In addition to considering officers in the promotion zone, the selection boards are authorized under the statutes of the Officer Personnel Act of 1947 to select a certain percentage of the total number of officers to be promoted from a "secondary" promotion zone. This zone is composed of officers who are considered for promotion ahead of their contemporaries, as a result of their previous outstanding performance.

The manner in which promotion zones are established varies among the services. For example, the Navy and Marine Corps establish a promotion zone, convene a selection board, and announce the selection of officers for promotion in each grade on a fixed schedule each year. However, the Army and Air Force convene selection boards and establish promotion zones at irregular intervals (up to three-year intervals in some cases). These boards are established when it appears that the service will run out of officers who have been selected by the preceding selection board for promotion to the next higher grade.

This discussion has pointed out the underlying reason for the existence and operation of selection boards, and for the variation in promotion

selection rate from year to year. Selection is used administratively to control promotions in accordance with the needs of the service, and as authorized grade distribution will permit.

In the case of the Navy, legal constraints also establish a minimum number of years in each grade and hence a minimum total commissioned service before becoming eligible for promotion. Only the naval service operates under these minimum times-in-grade constraints, and in some cases these constraints have been suspended by executive order.

One final legislative constraint, as established by the Officer Personnel Act of 1947 (and incorporated into Title 10, U.S. Code), acts on the existing grade structure. This constraint concerns separation of officers in the grades O-1, O-2, and O-3 twice failing selection for promotion to the next higher grade. These officers are separated from the service. In the grades O-4, O-5, and O-6, officers are guaranteed a statutory retirement after a minimum of 20, 26, and 30 years, respectively, without regard to failure of selection to the next higher grade.

All of the foregoing considerations in this section represent constraints which have been established by law and which can be changed only through further Congressional action. Therefore, these constraints are generally considered to be fixed when conducting any analysis of changes in officer grade structure resulting from introduction of new policies. In proposing any new structure, new Congressional legislation would have to be passed if such a structure exceeds the legal constraints presently in existence. This could prove to be the most difficult step in implementing a new officer grade structure.

C. DEPARTMENT OF THE ARMY, OFFICER GRADE STRUCTURE STUDY

This section presents a review of the Officer Grade Structure Study [Ref. 5], prepared by the Personnel Studies Division, Directorate of Personnel Studies and Research, Office of the Deputy Chief of Staff for Personnel, Department of the Army. The study presents an investigation of the Army officer structure, and was published in March, 1969. The overall classification of the study is SECRET, but only UNCLASSIFIED portions are used in this paper.

The purpose of this study was to establish a sustainable officer structure for the Army through 1975-1985. The general objectives of the study were: [Ref. 5]

"(1) To develop an officer structure which will be capable of providing, both in quantity and quality, the military leadership needed by the Active Army to carry out its assigned missions from now through 1985.

(2) To develop an officer structure which will be career attractive and sustainable regardless of officer strength fluctuations."

The specific objectives of the study were:

"(1) To determine officer requirements in terms of an officer structure that will meet current and anticipated missions through 1985.

(2) To develop a practical means of adjusting to fluctuating force levels, including a possible post-hostilities phasedown, concurrently maintaining required quantitative and qualitative levels and acceptable career development.

(3) To recommend improvements of policies and programs within the personnel management functions which influence the officer structure.

(4) To determine whether legislative changes or Office of the Secretary of Defense (OSD) program changes are required to attain and support the officer structure developed in this study."

The study focused attention on Active Army officer requirements, distribution of experience levels, sustainment capabilities at an acceptable level of officer quality, and provisions for satisfying career progression for officers. The study did not investigate warrant officer career management, branch and MOS assignments, and personnel readiness. As an output, the study developed alternative officer baselines¹, using guidance from the Five Year Defense Program (FYDP), Joint Strategic Objectives Plan (JSOP), Basic Army Strength Estimate (BASE), Army Force Development Plan (AFDP), Army 85 Concept Study, and T-day planning guidance.

Before developing the actual grade structure, the study group recognized that no criteria for an optimal structure exists, and thus certain aspects of acceptability and desirability were investigated. These aspects resemble those presented in Section IV "A" of this paper, and they served as guidelines in judging the relative merits of the different proposed structures.

¹A "baseline" is defined as "the Active Army end strength considered to be the minimum required to meet normal peacetime missions; a relatively stable end strength from which the Army can expand in the event of hostilities or other national emergency and to which the Army would contract upon resumption of normal peacetime conditions." [Ref. 5]

(3) Three-year, five-year, and ten-year retention rates which will be required to sustain this structure.

(4) Two-year and twenty-year retention rates, if they were not provided as inputs.

(5) The number of officers over or short of actual present officer strength that is required to maintain the proposed structure.

Thus, in summary, the model calculates for each set of inputs the requirements for sustainability of the structure, overages, underages by grade, retention rates at different career points, and the necessary six-month procurement rate of second lieutenants to sustain this proposed structure.

The basis for the model is linear programming. In this type of optimization problem, the grade strength authorization inputs are treated as goals to be attained "as-closely-as-possible," given the promotion points, promotion rates, and attrition rates. The problem is formulated as follows:

$$\text{Minimize: } CX + DY + EZ \quad (1)$$

$$\text{Subject to: } PX + Y - Z = B \quad (2)$$

$$x_i \leq x_{i-1}, \quad i=2, \dots, 6 \quad (3)$$

$$z_i \leq .05b_i, \quad i=4, 5, 6 \quad (4)$$

where:

$C = (c_1, c_2, \dots, c_6)$, $D = (d_1, d_2, \dots, d_6)$, and $E = (e_1, e_2, \dots, e_6)$ are vectors whose elements represent "cost" coefficients,

$i = 1, 2, \dots, 6$ (grade 0-1, 0-2, ..., 0-6). Grades 0-1, 0-2, 0-3 are company grade ranks; grades 0-4, 0-5, and 0-6 are field grade ranks,

$j = 1, 2, \dots, 6$ (periods of length of active federal commissioned service (AFCS)), ($j = 1$ represents $0 < \text{AFCS} < 2$, $j = 2$ represents $2 < \text{AFCS} < 3$, $j = 3$ represents $3 < \text{AFCS} < 5$, $j = 4$ represents $5 < \text{AFCS} < 10$, $j = 5$ represents $10 < \text{AFCS} < 20$, and $j = 6$ represents $20 < \text{AFCS}$). See Figure 1.

$X = (x_1, x_2, \dots, x_6)$, where x_1 = steady state input of 2LT's per 6 month period, and x_j ($j = 2, 3, \dots, 6$) = number of men in an input group (cohort) who stay in the service until period "j."

$Y = (y_1, y_2, \dots, y_6)$; where y_i is the underage in grade i .

$Z = (z_1, z_2, \dots, z_6)$; where z_i is the overage in grade i .

$P = (p_{ij})$ is a 6×6 matrix where p_{ij} is the average number of six month periods spent in grade "i" by an officer with "j" periods of service time

$B = (b_1, b_2, \dots, b_6)$; where b_i is the authorization for each grade i .

Thus, equation (1) represents the objective function, with the objective of minimizing total "cost" of procuring and retaining the desired officer structure while keeping costs of overages and underages low. Equation (2) is simply an inventory equation, while equation (3) requires decreasing cohort size in increasing time periods, and equation (4) represents an additional constraint on the overages allowed for field grade officers.

This problem is formulated in a somewhat different form in Appendices I and II to Annex A of Reference 5, the Officer Grade Structure Study. In Ref. 5, the constraints on overages of officers in field grades are formulated, in contrast to equation (4), in such a way as to permit overage for a particular grade to exceed $.05b_i$, the authorization for that

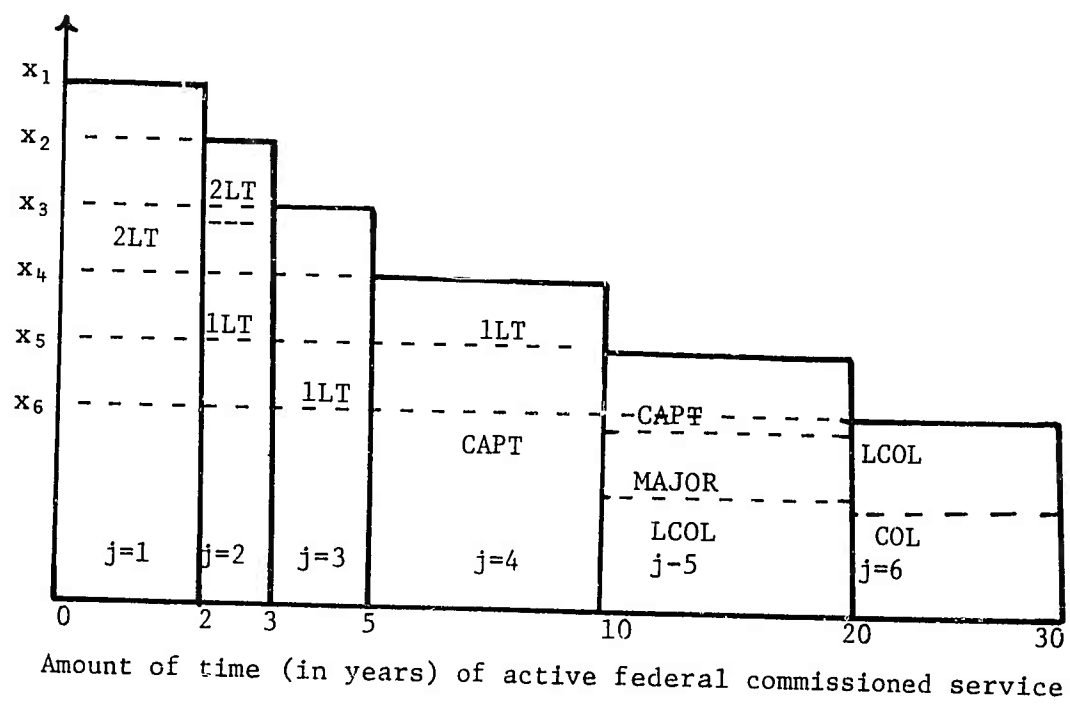


FIGURE 1. COHORT BEHAVIOR AS A FUNCTION OF TIME IN SERVICE

grade. This overage of an overage seems to defeat the very purpose of the constraint that has been applied.

The cost coefficients C, D, and E require further explanation. The values assigned to each element are arbitrarily established by the planner or policy maker operating the model, and should be thought of as relative weights rather than costs. Their units are not mentioned in reference 5. The coefficients actually used in the operation of the model were:

$$(c_1, c_2, \dots, c_6) = 1, \quad (d_1, d_2, d_3) = 1, \quad (d_4, d_5, d_6) \text{ and } (e_1, e_2, \dots, e_6) = 4.$$

These put relatively high weights on underages in field-grade ranks and overages in all ranks. A change in these cost coefficients could create a solution which differs considerably from that obtained using the above values.

The problem is solved using standard linear programming codes [Ref. 10]. The grade structure obtained is interpreted as the steady-state result of procuring x_1 men in each time period and tracing their careers for an entire 30-year period with given promotion points, promotion rates, and attrition rates. Each period in service, across all grades, lists how this group of x_1 men is distributed throughout the 30-year period, usually referred to as a "service distribution."

In addition to the cost coefficients, the parameters of promotion selection rate and time in grade offer the primary means for controlling the resulting structure. The structure was shown to be highly sensitive to even minor adjustments in time in grade, and moderately sensitive to adjustments in promotion rates. Sensitivity analysis of these two variables can easily be conducted by the planner.

Two points of criticism of the model are in order. First, there are serious errors in the mathematical formulation. Appendix II to Annex A of the Officer Grade Structure Study contains the basic mathematical derivations used in developing values for the $P(I,J)$ coefficients. Equation (1) of this appendix states:

$$a_n = \frac{X}{(1+a)^n}, \quad (5)$$

where a_n is the number of second lieutenants remaining at the end of their obligated tour of n six-month periods, X is the rate at which second lieutenants are procured per six-month time period, and during the period these second lieutenants are lost at a rate a ($0 \leq a \leq 1$) per six-month period. In fact, the equation for determining the number of second lieutenants remaining at the end of their obligated tour should be:

$$a_n = X(1-a)^n. \quad (6)$$

For example, let $n = 1$ and let $a = 1.0$ (i.e. 100% attrition; all X second lieutenants are lost). Equation (6) correctly shows that $a_1 = 0$ at the end of that single period. However, equation (5), the one used in Appendix II, shows that $a_1 = X/2$ officers remain, even with 100% attrition!

The second point of criticism is that no mention is made of duality. The dual variables could be used to tell the relative prices of the constraints (overages, underages, etc.). Shadow prices could help the planner or policy maker determine how binding each constraint is, and could be

helpful in determining which of the constraints could be most profitably changed in attempting to further minimize the objective function.

All of the conceptual and technical developments of this study group lead to the use of the OGSM to develop structures to be recommended to the Secretary of the Army for each of seven branch test strengths which might conceivably be imposed on the Army in the next decade. These different test strengths were obtained from various policy guidance decisions which would affect the size of the Army in 1975-1985. Some 2500 runs of the OGSM were made to arrive at structures which best satisfied these policy directives and still met the criteria of acceptability and desirability. The detailed picture of each of these seven structures was presented as a separate, classified volume of this study report. For each of these structures, the presentation included a detailed cell-by-cell and total content of the structure recommended, distributed by categories of early, normal, and late promotions in the grades second lieutenant through colonel, and by amount of commissioned service within each grade. Additionally, the report presented the specific promotion rates applicable to each officer group within each grade, and the applicable retention rates for officers in each group who were not selected for promotion.

The final area of analysis by the study group centered on a comparison of the seven structures developed. The objective of this analysis was to choose the most desirable structure, considering the prime factors of capability of expansion of each structure, readiness implications (i.e. maintaining military preparedness), and the impact on the Officer Corps during

phasedown. Each of the seven structures was felt to be sustainable; therefore, based on the factors considered above, the largest of the seven structures was deemed to be most preferred by the study group. The recommendations of the study group presented this finding, along with several alternative baseline officer structures which would be recommended if policy directives establishing smaller Army end strengths were implemented.

In summary, it is worthwhile to review the capabilities and limitations of the Officer Grade Structure Model. The model attempts to:

- (1) Design an officer grade structure with or without legislative, force structure, or any other single constraint, which best satisfies the Army's manning and readiness objectives.

- (2) Determine weaknesses in existing promotion policies by demonstrating their predicted long-term effects.

- (3) Project problems which can be expected to occur over the long term based on current promotion and retention rates, grade strengths, times in grade, retirement rates, and constant input rates.

- (4) Determine the approximate retention rates necessary for long term sustainment of officer grade strengths.

- (5) Display the "ideal" grade distribution by time in grade and time in commissioned service for the Army and/or each branch.

Some of the model limitations are:

- (1) The OGSM is a static model, and is valid only as long as present policies and input data continue to apply. Change in management goals over time are not taken into account. Since some of the policy inputs, such as

end strength figures, attrition, and retention rates cannot be positively controlled by the Army, the "ideal" structure requires repeated updating.

(2) The OGSM does not efficiently adjust to changing force levels, because it is not able to provide for conversion from the present structure to any new structure.

(3) The model only approximates promotion zones, since it specifies time in grade and time-blocks in six-month intervals when in fact promotion and attrition occur and can be regulated by the day. An obviously more complex programming modification could overcome this minor limitation.

(4) The "ideal" or "optimal" structure generated by the model may be neither ideal nor optimal, since it is simply a modification of the present structure in accordance with certain rules assigning relative costs to overages and underages in certain grades and then further analyzed in light of certain rules for acceptability and desirability.

(5) Any results from the existing model are meaningless with the errors present in the mathematical formulation. These could easily be corrected.

LIST OF REFERENCES AND SELECTED BIBLIOGRAPHY

1. Institute of Naval Studies, Study No. 13, Manpower Considerations Applicable to the Navy in the 1970-1980 Time Period, 1966, The Franklin Institute, Washington, D. C.
2. Institute of Naval Studies, Research Contribution #17, Predicting Effectiveness of Incentive Programs for Various Groups of Naval Officers, by Charles M. Harsh, 31 March 1966.
3. Office of the Secretary of the Navy, Report of the Secretary of the Navy's Task Force on Navy/Marine Corps Personnel Retention, 1966, Department of the Navy, Washington, D. C. (Chapter 16 contains an extensive bibliography.)
4. The Franklin Institute Research Laboratory, Career Motivation of Army Personnel - Junior Officer Duties, by David L. Franklin and others, 30 September 1968. (This reference contains a sizable bibliography on pages 87-92.)
5. Department of the Army, Office of the Deputy Chief of Staff of Personnel, Officer Grade Structure Study, 1969. (Annex C of this reference presents a list of 265 reference pertinent to grade structure investigations.)
6. United States Code, Title 10, Armed Forces, 1964 Edition, Government Printing Office, Washington, D. C.
7. United States Statutes at Large, Public Law 83-349, 83rd Congress, 2nd Session, Vol. 68, 1954, Government Printing Office, Washington, D. C.
8. Anderson, T. W., "Asymptotic Theory for Principal Component Analysis," Annals of Mathematical Statistics, Vol. 34, p. 122-148, 1963.
9. Bartlett, M. S., "Multivariate Analysis," Journal of the Royal Statistical Society (Supplement), Vol. 9, p. 116-190, 1947.
10. Dantzig, G. B., Linear Programming and Extensions, Princeton University Press and RAND Corporation, 1963.
11. Dixon, W. J. ed., BMD Biomedical Computer Programs, Health Sciences Computing Facility, U.C.L.A., 1965.
12. Lawley, D. N., "Tests of Significance in Canonical Analysis," Biometrika, Vol. 46, p. 59-66, 1959.

13. Ostle, B., Statistics in Research, Iowa State University Press, 1963.
14. Siegel, S., Nonparametric Statistics in Behavioral Sciences, McGraw Hill, 1956.
15. Headquarters, Department of the Army, Department of the Army Pamphlet No. 600-20, Personnel - General, Junior Officer Retention, 1 August 1969.

SELECTED BIBLIOGRAPHY

16. Barnes, E. L., Jr., Models of Senior Naval Officers Ranks, M. S. Thesis, Naval Postgraduate School, Monterey, California, 1970.
17. Bureau of Naval Personnel Report No. 10462-N12-2, Officer Management Simulation Model, January 1969.
18. Gardner, G. L., The Input Requirements Computation Model, (IRCM), paper presented at the Military Operations Research Symposium, 23rd, West Point, New York, 16 June 1969.
19. Personnel Research Laboratory Report PRL-TR-64-14, Markov Chain Theory Applied to the Prediction of Retirement Rates, by F. D. Harding and J. W. Merck, June 1964.
20. RAND Corporation Research Memorandum RM-2611, Concepts for Estimating Air Force Requirements for Planning Purposes, by M. C. Heuston, 1 December 1960.
21. Jones, E., "Officer Career Planning in the Royal Navy," Operational Research Quarterly, Vol. 20, No. 1, p. 33-44, March 1969.
22. Klingerman, J. L., Predicting Attrition of United States Marine Corps Officers by Rank and Military Occupational Specialty, M.S. Thesis, Naval Postgraduate School, Monterey, California, 1970.
23. American Institute for Research, Operational Analysis of the Naval Personnel System, Part III, Development of the Enlisted Personnel Simulation System, by W. J. Knetz, October 1963.
24. Naval Personnel and Training Research Laboratory Research Report SRR-70-15, A Study of the Use of Historical Data In Naval Officer Personnel Management, by J. S. Malone and R. P. Thorpe, December 1969.
25. McAfee, C. K., A Cohort Model for Predicting Retention of Regular Marine Corps Officers, M. S. Thesis, Naval Postgraduate School, Monterey, California, 1970.